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Abstract: Large organizations wield considerable market power, their procurement activities can be leveraged to achieve social, economic and environmental goals by 'pulling' more desirable products into the market. However, while there is substantial research in individual consumer buying behavior and market barriers to sustainable technology adoption, less is known about large organizational buying behavior and the impact of institutional barriers in this area. To address these research gaps, we conducted an exploratory study aimed at better understanding the process through which large organizations purchase sustainable energy technologies and what internal barriers they experience during that process. We surveyed and interviewed 120

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individuals involved in procurement from Californian organizations representing both public and private sectors. Survey results indicate the need to resolve the conflict between prioritizing lowest first cost and lowest life cycle cost, better engage multiple stakeholders involved in internal decision-making around purchasing, and improve existing procurement tools or offer new ones. We provide recommendations for how policymakers can apply our findings to increase the adoption of sustainable energy technologies in their own organizations and communities.

Keywords: *sustainable energy technologies; technology adoption; sustainable procurement; institutional barriers; organizational change*

1. Introduction

California made history in 2018 by committing to some of the most ambitious climate targets in the U.S.. The 100 Percent Clean Energy Act of 2018[5] requires California to obtain 100 percent of its electricity from zero-carbon sources by 2045 and an executive order[6] committed the state to reaching economy-wide carbon neutrality by 2045. To meet these targets, California must drastically increase the adoption of various sustainable energy technologies, which include energy efficient technologies, energy storage, electric vehicles, distributed generation, and demand response technologies.

Researchers have devoted great effort to understand and leverage *individual* consumer buying behavior (Stern, 1999; Gadenne, 2011; Mills, 2012) to increase the adoption of sustainable energy technologies, however less is known about how *organizational* buying behavior and decision-making processes also impacts the adoption of sustainable energy technologies. Additionally, existing literature (Howarth & Andersson, 1993; Golove & Eto, 1996; Weber, 1997; Brown 2001; Brunke et al. 2014) most often focuses on market barriers to sustainable energy resource adoption, but the role that institutional barriers play in limiting uptake among large organizations is often overlooked.

To address these two research gaps -- both the lack of research on organizational buying behavior and institutional barriers to technology adoption -- we conducted an exploratory study which surveyed over 100 different large California organizations to better understand the buying

5 California Senate Bill 100 (De León)
6 California Executive Order B-55-18 (Brown)

behavior of large organizations and the resulting institutional barriers that can prevent the purchasing of sustainable energy technologies. This research helped to inform the development of a procurement assistance program, Empower Procurement,[7] aimed at accelerating the adoption of sustainable energy technology for large organizations in California and provided insights into the two research gaps.

1.1 The importance of procurement in accelerating sustainable energy technology adoption among large organizations

Procurement from large organizations, such as state agencies and city governments, accounts for at least 10 to 15 percent of gross domestic product in developed countries (Edquist, C. et al., 2015). The U.S. federal government alone represents the single largest buyer of products and services in the world (Environmental Protection Agency, 2020). Leveraging this substantial purchasing power by encouraging large organizations to purchase sustainable energy products and services can create greater demand in the market, lower the cost of sustainable energy technology adoption, and even 'pull' new sustainable technologies into the market. This requires understanding the internal practices that shape how large organizations make purchasing decisions. This study mainly focused on large organizations that have a designated procurement department, structured procurement policies, use specific procurement tools, and usually have over 500 employees. 'Organization' is any entity that brings groups of people and resources together to achieve a common outcome (March & Simon, 1985). An organization is composed of chains of command with delineated responsibilities and internal processes that influence how decision-makers interact and determine the use of specific resources (Hodgson, 2006). This

7 https://empowerprocurement.com

paper focuses on the practices surrounding procurement (i.e., the decision-making process around purchasing and the acquisition of goods and services) that occur within large organizations. Together, these practices determine certain outcomes and influence behavior, such as organizational decision-making around what to buy. This decision-making process is distinct and often more complicated than the decision-making process of an individual. First, the theory of bounded rationality posits that constraints on organizational capacities (e.g. limited information, various institutional rules, and finite resources) often cause decision-makers within an organization to seek the *easiest* optimal solution (Simon, 1972; Cooremans, 2009), overlooking other considerations that are harder to quantify (i.e., social attributes). Second, organizational decision-making requires the coordination of multiple decision-makers, each with complex hierarchical roles and responsibilities, who often prioritize different objectives within their organization. Finally, organizational factors can cause decision makers to act differently than if they were functioning alone (Webster & Wind, 1996). Better understanding of the internal decision-making processes and procurement practices of organizations can provide policymakers with a new lens through which to design effective and targeted interventions aimed at increasing the adoption of sustainable energy technology by large organizations.

The collective buying power of large organizations offers a clear opportunity to achieve desirable social, economic, and environmental goals (McCrudden, 2004). Despite this large purchasing power, procurement is often overlooked as a mechanism through which to achieve carbon emission reductions and energy savings. This oversight is partly due to a knowledge gap regarding the various roles, rules, and tools that impact how organizations acquire sustainable energy technologies. By better illuminating the procurement process within large organizations and how it relates to technology adoption, this paper can equip policymakers and business leaders with the insights needed to more effectively leverage the buying power of large organizations to accelerate uptake of sustainable energy technologies.

1.2 Barriers to sustainable energy technology adoption

Policies aimed at increasing the adoption of sustainable energy technology often focus on the structure and function of the marketplace. Much of existing literature examines market barriers to sustainable energy technology adoption (Jaffe & Stavins, 1994; Brown, 2001). Common market barriers to sustainable energy technology adoption include high initial cost (Egbue & Long, 2012), unpriced energy costs (Nichols 1994; Brown, 2001), R&D spillover (Gillingham & Sweeney, 2010), and split-incentives (Backlund et al., 2012). While market barriers may account for some aspects of why organizations do not purchase certain sustainable energy technologies, they alone do not fully explain what prevents the adoption of sustainable energy among large organizations (Zilahy, 2004). Other factors, such as institutional barriers, also limit sustainable energy technologies adoption even when market barriers have been sufficiently addressed. For example, if an organization does not have the expertise or capacity to develop up-to-date and clear technical specifications for an efficient LED lighting system, then an organization may struggle to adopt that product even though it is commercially available and cost effective. It is thus important to recognize that barriers in the market *and* factors within an organization can limit adoption of clean energy resources. A mounting body of research recognizes sustainable energy adoption as an interdisciplinary issue that requires addressing organizational and behavioral barriers in addition to economic and technical challenges (Thollander et al., 2010).

Building on the larger body of literature on market barriers, some studies (Blumstein et al. 1980; Jaffe et al. 1994; DeCanio 1998; Painuly & Fenhann 2002; Margolis & Zuboy, 2006; Sorrell et al. 2011; Timilsina et al. 2016) posit a range of institutional barriers that may limit sustainable energy technology adoption. For this paper, 'institutional barriers' can be understood as factors within an organization that limit the acquisition of sustainable energy technologies. First, many large organizations limit access to financing options or are simply unaware of existing options (Mirza et al., 2009). Second, organizations may find it difficult to implement sustainable energy technologies because they have insufficient time and resources to learn about new technologies (Painuly & Fenhann, 2002). Third, organization stakeholders often lack cohesive internal communications, such that major procurement actors are insufficiently engaged in prioritizing the acquisition of sustainable energy technologies. Additionally, as the theory of bounded rationality suggests, when it comes to acquisitions decisions, capacity constraints often lead organizations to prioritize the lowest first cost, since it is much easier to determine and compare across products and services than life cycle cost or social benefits. This higher emphasis on lowest first cost, combined with a general culture of risk aversion (Adetunji et al., 2008) may lead top-level organizational management to place a lower priority on energy savings when making purchasing decisions (Hasanbeigi et al., 2010) -- representing aninstitutional barrier to the adoption of sustainable energy technologies.

While significant policy and research focuses on addressing market barriers, institutional barriers to sustainable energy technology adoption remain a largely unexplored research area and yet understanding those barriers is a clear prerequisite to accelerating adoption of sustainable energy technologies. Our research aims to provide greater understanding of organizational buyer behavior and identify the institutional barriers that frequently prevent large organizations from acquiring sustainable energy technologies.

2. Methods

To elicit information about how California organizations make purchasing decisions and what barriers exist for sustainable energy technology deployment for both public and private sectors, we developed an online survey for procurement professionals in large California organizations. Prior to the survey, we conducted pilot interviews with 12 procurement professionals. Upon deploying the survey, we received 108 responses and conducted follow up interviews with 34 of those participants.

2.1 Survey design

Previous research on organizational change and procurement pathways conducted at Lawrence Berkeley National Laboratory and preliminary research on the barriers to the adoption of sustainable energy technology products within existing purchasing channels in the state of California informed the questionnaire. These informed our initial hypotheses about what organizational factors were likely to affect the adoption of sustainable energy technology within large organizations. Existing research also suggested potential differences between the public and private sectors and the need to explore those differences (Erridge et al. 2001; Thai, 2001; Thai et al., 2004; Telgen et al., 2012). Based on this reasoning, we organized the survey into questions about sectors, rules and procedures for purchasing, procurement roles, and tools related to procurement and specific product types. Prior to deploying the full survey, we contacted 50 individuals involved in procurement in both the public and private sector from within our professional networks whom we believed would have useful insights as practitioners. We conducted semi-structured pilot interviews with 12 of them to refine the survey questions. Each pilot interview lasted approximately 30 minutes. Participants were asked to describe their interpretation of survey questions and key terms, explain their role in the procurement process in their organizations, and discuss the perceived barriers and opportunities for the purchasing of new sustainable energy technology products that existed within their organizations.

After refining our questions based on the feedback we received from the pilot interviews, the full survey was then administered online via SurveyMonkey between February and May 2019. We defined our target population as any individual with a role in the procurement process working for an organization large enough to have formal procurement staff, policies, and tools within the state of California. It included procurement professionals as well as key influencers in the purchasing process, such as facilities managers, sustainability and energy managers, and executives. To ensure a representative sample of California organizations and enable a comparison of public and private sectors, large organizations from both sectors were identified and contacted, including organizations in: Architecture & Engineering (A/E) firms, Agriculture, Business/Finance, Commercial Real Estate, Entertainment, Federal Government, State Government, Local Government, Healthcare, Higher Education, K-12 Schools, Local Government, Manufacturing, Retail, Tech, Utilities, and more.

The survey team generated a contact list starting with ‘warm' contacts taken from personal or professional networks, and then building out to ‘cold' contacts obtained via online searches. The survey link was emailed directly to 436 contacts from this main contact list. Additionally, the survey team contacted various industry associations that agreed to distribute the survey to their established networks via newsletters and online mailings. Based on tracking estimates, the survey was circulated to an additional 2,680 individuals through these partner distributors. In total, the survey was sent to approximately 3,116 individuals. After early results showed low participation in specific sectors, the survey team provided gift card-type incentives to potential respondents in an attempt to increase response rates and representation from under-represented sectors. At the conclusion of the survey, we received 108 responses (62 from the public sector and 46 from the private sector) and conducted 34 follow-up interviews with those respondents who had indicated their willingness to participate, which provided a more holistic perspective.

To determine whether procurement varies between public or private sector organizations, thus requiring different interventions, we conducted further analysis of our results using Fisher's exact test (as detailed in the following section). The survey team aimed to get 300 responses or 150 responses for each sector[8] to achieve a 95% confidence level with a 5% margin of error. However, 108 responses were collected for a response rate of 0.03%.

2.2 Data analysis

To analyze the survey data, the research team first reviewed raw data from each question to understand respondents' demographics, what role they have in their organization, what procurement practices they follow, and what procurement tools they use. After conducting an initial analysis of the raw survey data, we then tested several hypotheses (Table 1) in order to reveal more in-depth relationships and trends in the data that may be relevant to understanding

8 According to California labor statistics , approximately 150,000 people in the state of California have a job related to procurement (OES State Occupational Employment and Wage Estimates, 2019). This is the figure we used to set our target respondent rate.

impact on sustainable energy technology adoption. We developed these hypotheses to test whether the procurement roles, practices, and tools varied among organizations based on sector.

Table 1 List of hypotheses tested

1	Respondents from different sector types have the same major influencers during the procurement process
2	Respondents from different sector types have the same procurement priorities
3	Respondents from different sector types have the same bottlenecks during the procurement process
4	Respondents from different sector types have the same prevention factor during the procurement process
5	Respondents from different sector types use the same tools during the procurement process
6	Respondents from different sector types buy the same type of products
7	Respondents from different sector types buy the same type of services
8	Respondents from different sector types prioritize the same product to procure for the next 5 years
9	Respondents from different sector types are interested in the same type of procurement support

Due to a relatively small number of responses, Fisher's exact test was selected as the best method for testing statistically significant differences and calculating p-value using our dataset (Agresti, A and Lui, L.M., 1999; Bilder, C.R, 2004). Though Fisher's exact test has been criticized as too conservative when predicting interrelation between groups, the low response rate necessitated its use in this study because it is typically more accurate than the other testing methods when expected numbers and samples are small (McDonald, J.H. 2014). A significance level of 0.05 was used, meaning a p-value smaller than 0.05 indicates a statistical difference between the groups tested.

3. Results & Discussion

This section presents findings from our survey data on each of the main components of procurement within large organizations -- beginning with the internal rules, roles, and tools that affect an organization's acquisition of new products or services, then examining the differences between public and private procurement, and finally discussing possible interventions that could improve the procurement process. The section concludes with an overview of the limitations that qualify these results.

In total, the survey received 108 survey responses from organizations representing 13 of the target sectors (Table 2). Most survey respondents indicated they are responsible for managing/developing projects at their respective organization in relation to procurement (Table 3).

Table 2. Respondent Sectors

Industry Type	Number of responses
Public	62
Private	46

Table 3. Respondent Roles

Type of Roles	Number of responses
Managing / developing projects	78
Reviewing proposals	53
Specifying the attributes of item being purchased	40
Developing contract documents	38
Approving expenditures	35

3.5 Rules that impact sustainable energy technology procurement

Building from previous research on procurement within large organizations, we knew prior to conducting this survey that organizations often have rigid institutional rules around procurement to ensure that purchasing only occurs through specific pathways and with the appropriate use of funds. These rules around purchasing, both formalized and informal, have a significant impact on the purchasing of sustainable energy technologies. Different organizations can value product attributes to varying degrees when it comes to choosing a new product to purchase, determining how to prioritize a product for purchase based on environmental characteristics, social characteristics, or economic characteristics. To help ensure that sustainable energy technology is better prioritized during procurement, an organization's decision-makers should be empowered with formal mandates directing them to place a higher value on sustainable energy technologies attributes (e.g., high energy efficiency) (Stenberg, 2007).

Our analysis from this survey revealed new findings about the rules in place among large organizations that govern acquisitions and how these rules may affect the ability to purchase sustainable energy technologies. In order to determine what attributes were prioritized most during purchasing, we presented respondents with a list of procurement objectives and asked them to rank product attributes in order of importance. A majority of respondents ranked 'Lowest first cost' (70% chose as high priority) and 'Lowest life cycle cost' (58% chose as high priority) the highest, as opposed to environmental or social attributes. Figure 1 shows the rankings of priorities.

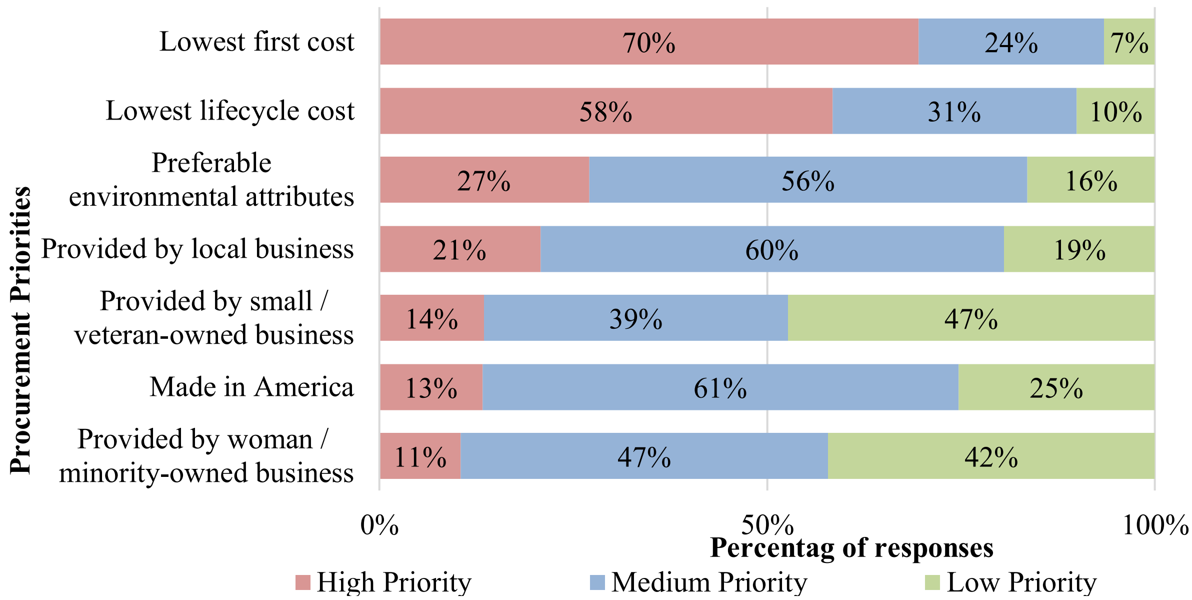

Figure 1. Rankings of product attributes most valued during procurement

The survey results reveal a clear intention among organizations to minimize cost. A majority of respondents (70%) ranked lowest first cost as the highest priority during procurement, followed by lowest life cycle cost (55%). Even though it may be in an organization's best economical interest to prioritize minimizing life cycle cost, we see a greater priority on lowest first cost compared to lowest life cycle cost, consistent with findings in existing literature. The concept of assessing energy-related products and services procurement based on life cycle costing has been long-standing (McEachorn, 1978), but it is still not commonly pursued with organizations due to lack of institutional rules that prioritize life cycle costing, the perceived lack of standard method to calculate life cycle cost, and limited feasibility of comparing life cycle cost among different procurement (Chiurugwi et. al, 2010). Furthermore, large organizations typically focus on annual spends and costs when budgeting rather than evaluating cost savings in the long term. This means they may miss the large lifetime savings potential offered by many sustainable energy technology products.

Additionally, one respondent noted in a write-in response that:

> "*… different stakeholders within each organization will prioritize these goals very differently. If the sustainability team is leading an initiative, you would see a very different emphasis and prioritization than most of the rest of the organization. Also, 'Made in America' becomes priority #1 if the project funding comes from state or federal agencies as that can be a prerequisite to receive the funding. However, on non-state or* [non-]*federally-funded projects, that goal becomes much less a priority."*

This suggests that procurement priorities may shift based on who is making the purchasing decision within an organization, meaning there is an additional level of complexity when it comes to assessing the internal processes that impact how a product or service is purchased.

3.2 Roles that impact sustainable energy technology procurement

Second, analysis of the survey data yielded insights into the types of decision-makers within organizations that influence the acquisition of sustainable energy technology. To assess which sets of actors exerted the greatest influence over the procurement process related to sustainable energy technology, respondents were asked to select any roles that they considered to be 'Major Influencers' within their organization from a list of nine options. A majority of respondents (51%) selected Chief Financial Officer, followed by Facilities Managers, and Energy Managers (Table 4).

Table 4. Types of role considered to be "major influencers."

Roles	% of responses
Chief Financial Officer	51%
Facilities Manager/Engineer	50%

Energy Manager	46%
Sustainability Manager	23%
IT Managers	21%
Contract Officer	21%
Fleet Manager	16%
External consultants	15%
Legal Counsel	8%

This data suggests that top-level managers, as well as those who specify products and services to buy (e.g., facilities managers, energy managers) play a significant role in the procurement of sustainable energy technology among most organizations. However, when we asked respondents to indicate what factors frequently prevent the adoption of sustainable energy technology at their organizations, 75% of the survey respondents indicated that a lack of top management support and lack of staff buy-in are at least sometimes a factor that prevent the purchase of new sustainable energy technology (Figure 2). This indicates that people in key decision-making roles (e.g., top management) and other stakeholders are not prioritizing sustainable energy technology at many large organizations. Furthermore, a majority of respondents find ‘Gaining approval' as a phase that is ‘Always' or ‘Often' a bottleneck during the procurement process. Over 50% of respondents with approval roles indicated they also have difficulties approving. Follow-up interviews with survey takers revealed that many approvers lack sufficient information about sustainable energy technology, which can lead to delays during the approval phase of procurement. Lack of sufficient justification for purchasing sustainable energy technologies may be a result of poor internal communication among stakeholders and staff.

Additionally, approvers are bound by the complex institutional rules and structure, which adds to the difficulties they experience in approving the purchasing of new sustainable energy technologies. Lastly, different influencers have different internal organizational objectives they are responsible for achieving. For example, a facility manager at a university is mainly responsible for maintaining building occupant comfort and optimizing building performance, while the financial officer is responsible for minimizing operation spending. Those objectives may sometimes conflict with each other, which may lead to conflicts among the different influencers and also contribute to difficulty in gaining approval.

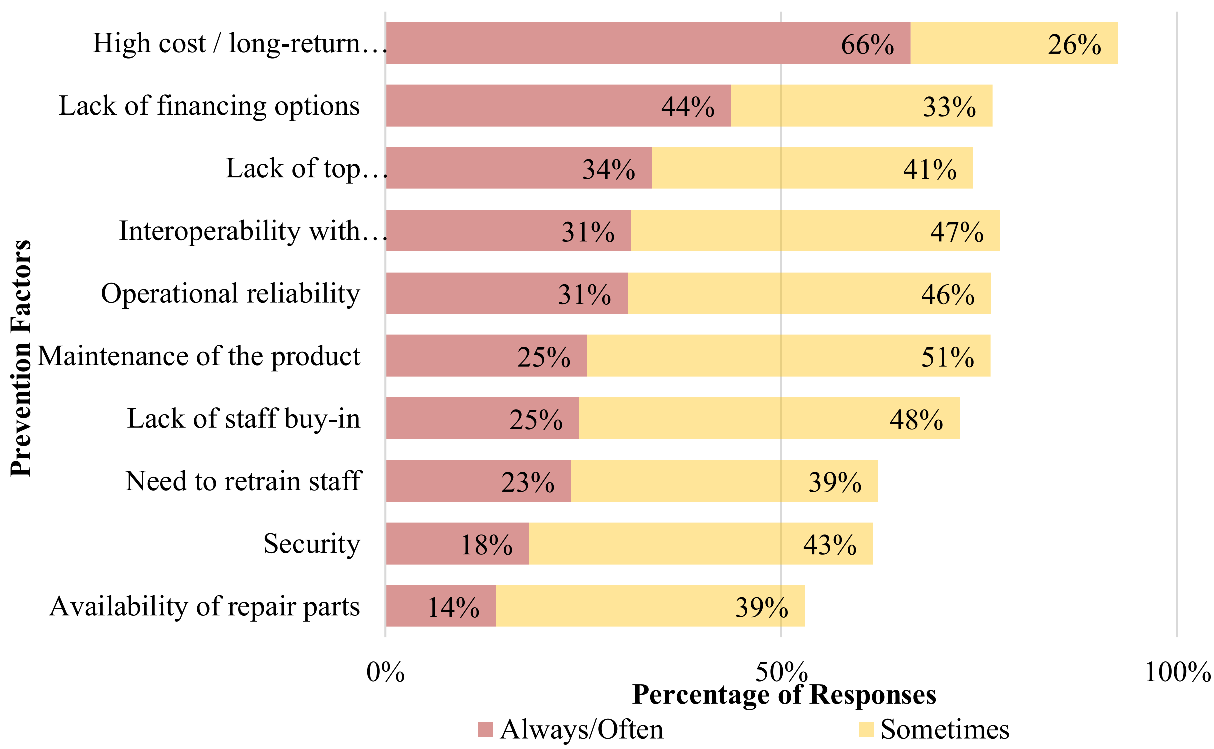

Figure 2. Common factors preventing organizations from purchasing new sustainable energy technologies

3.3 Tools that impact sustainable energy technology procurement

Finally, analysis also revealed key findings about the tools and resources for procurement currently in use by large organizations, and how they limit or in some cases prevent the adoption of sustainable energy technology. Large organizations use a variety of procurement tools, such as standardized contract and specification templates, purchase order requisition forms, software for contract development, and online marketplaces where products can be sought and purchased. These tools are developed to facilitate procurement of various products and services, reduce administrative burden, and ideally simplify the complex procurement process.

To better understand how tools impact sustainable energy technology procurement, we asked what type of tools are developed within an organization. Seventy-five percent (75%) of respondents indicated that they use standardized contract templates, sixty-six percent (66%) of respondents indicated that they use purchase order requisition forms, followed by forty-four percent (44%) of respondent indicated that they use standardized specification templates (Figure 3).

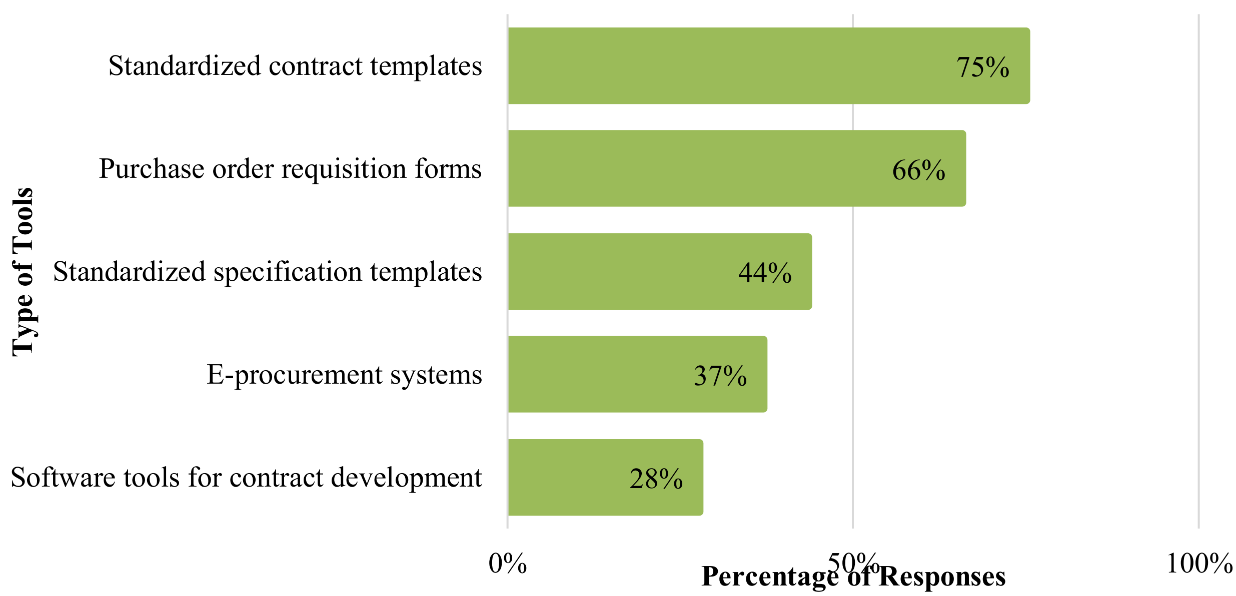

Figure 3. Type of tools respondents currently use for procurement

To better facilitate the increased purchasing of sustainable energy technology products, these tools must be able to provide salient information about sustainable energy technology product performance, environmental impacts, cost effectiveness, maintenance requirements and reliability, as well as associated risks (Vanier, 2001; Lutzkendorf & Lorenz, 2007). Utilizing standardized contract template and technical specification template are meant to expedite the procurement process.

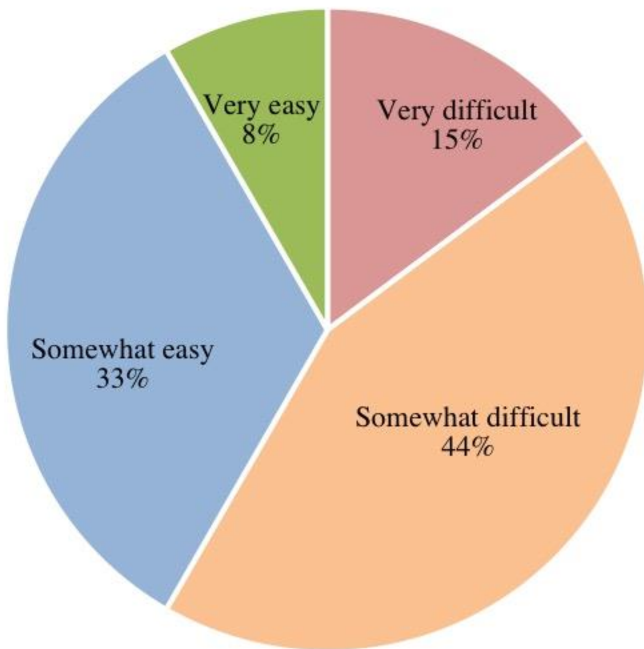

Figure 4. Respondents by level of difficulty experienced when adopting new sustainable energy technology products

However, when asked to indicate how easy it would be to purchase new sustainable energy technology products using the existing tools at their organization, about 60% of respondents indicated that it would be 'Very difficult' or 'Somewhat difficult' (Figure 4) to purchase new sustainable energy technology products using their existing tools. Additionally, 'developing contract documents' was reported as the second most frequent bottleneck indicated by a majority of respondents (Figure 5). This suggests that existing contracting templates are not effective at facilitating a smoother procurement process. The high ranking of 'Specifying and selecting products' as a common bottleneck during procurement also indicates that it is difficult for respondents to find products or get accurate information on the products they wish to buy, further adding to their administrative burden. These findings all reveal significant limitations with existing procurement tools, both in terms of making it easier to quickly and easily find and purchase products in general, and sustainable energy technology technologies specifically.

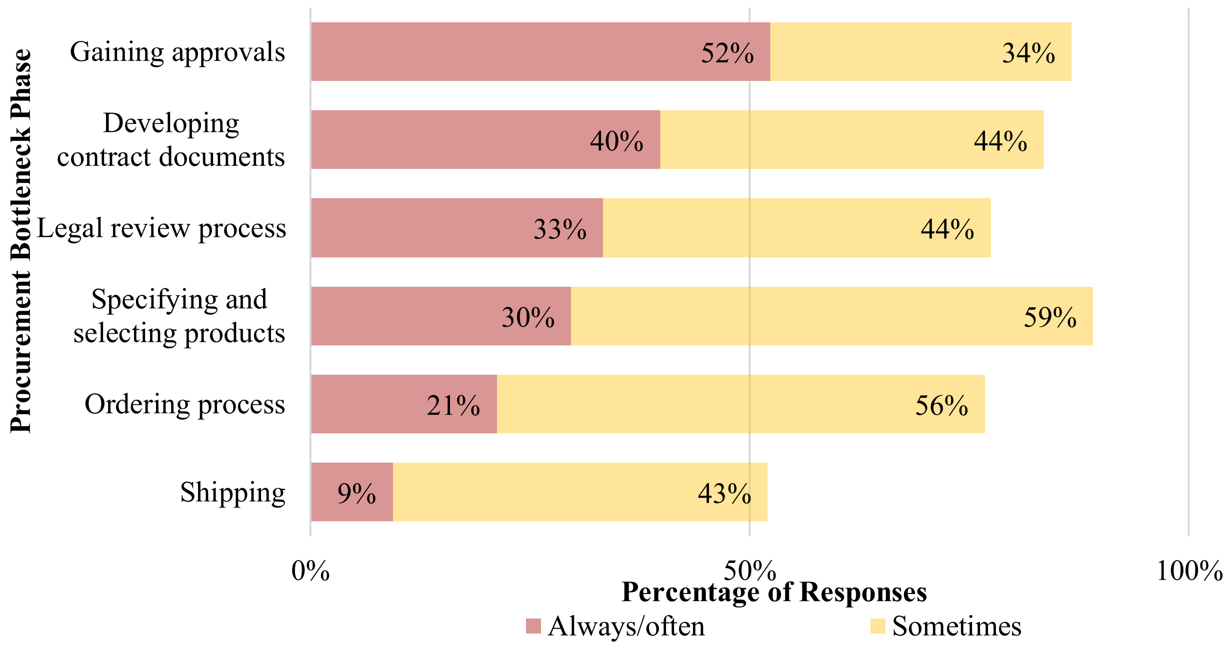

Figure 5. Frequent bottlenecks experienced by organizations during procurement

3.4 Comparing procurement among public and private sector organizations

Existing literature suggests that public sector procurement is more regulated than private sector procurement (Trepte, 2004), and there are more rules to comply with as to how a vendor can be selected or what product attributes should be prioritized. Under Federal Acquisition Regulations (FAR), federal public sector procurement tends to follow a practice known as Lowest Price Technically Acceptable (LPTA) rule when selecting a vendor, and both state and local public procurement also follow a similar practice (Nagle, 1992). This practice requires public procurement to select the vendor with the lowest price that meets the minimum legal and technical requirements. More recently, the Best-Value procurement approach is becoming more common, which allows public organizations to evaluate vendors more holistically. The private sector does not have legal binding to follow such a practice.

Nonetheless, across both sectors, organizations are risk-averse and tend to prioritize products that have the lowest first cost (Telgen et al., 2012). The various procurement priorities may mean that attributes that are more likely to be associated with sustainable energy products (e.g., energy-efficient) may lose out against other procurement objectives. Our analysis revealed possible procurement behavior differences between public and private organizations which could lead to different technology adoption outcomes (Table 5).

Table 5. Fisher's exact test results for hypotheses listed

Hypothesis		p-value	What it means
1	Respondents from different sector types have the same major influencers during the procurement process	0.018	A statistical difference that suggests respondents from public and private sectors have different major influencers regarding the purchasing of sustainable energy technologies
2	Respondents from different sector types have the same procurement priorities	0.701	No statistically significant difference, so unable to disprove that respondents in different sectors have the same procurement priorities
3	Respondents from different sector types have the same bottlenecks during the procurement process	0.230	No statistically significant difference, so unable to disprove that respondents in different sectors have the same bottleneck during the procurement process
4	Respondents from different sector types have the same prevention factor during the procurement process	0.433	No statistically significant difference, so unable to disprove that respondents in different sectors have the same prevention factor during the procurement process
5	Respondents from different sector types use the same tools during the procurement process	0.659	No statistically significant difference, so unable to disprove that respondents in different sectors use the same tools during the procurement process
6	Respondents from different sector types buy the same type of products	0.998	No statistically significant difference, so unable to prove that respondents in different sectors buy the same type of products

7	Respondents from different sector types buy the same type of services	0.998	No statistically significant difference, so unable to disprove that respondents in different sectors buy the same type of services
8	Respondents from different sector types prioritize the same product to procure for the next 5 years	0.125	No statistically significant difference, so unable to disprove that respondents in different sectors prioritize the same type of products
9	Respondents from different sector types are interested in the same type of procurement support	0.065	No statistically significant difference, so unable to disprove that respondents in different sectors are interested in the same type of procurement support. However, the p-value is close to the significance level, so warrants closer analysis.

**Cells highlighted in gray indicates a statistical difference is found among the different groups, which are tested against significance level of 0.05*

We assumed that respondents from different sector types would have the same major influencers during the procurement process, but the Fishers' exact test indicated different major influencers might exist during the procurement process for public and private sector organizations. Figure 6 shows that chief financial officers in private sector organizations may exert a stronger influence in procurement compared to public sector organizations. Facility manager/engineer and energy manager in public sector organizations may exert a stronger influencer in procurement compared to private sector organizations.

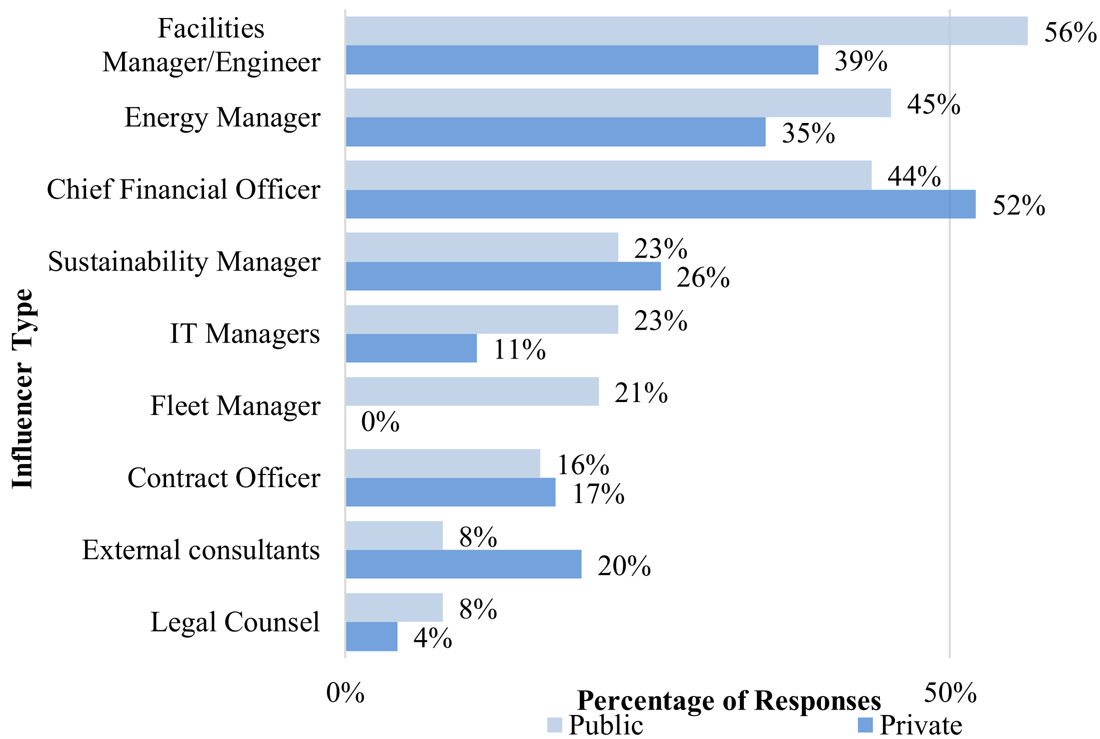

Figure 6. Major procurement influencers in public and private sectors

3.5 Areas of need

Beyond providing insights into the difficulties organizations face in purchasing sustainable energy technology, this survey also yielded findings that are useful for thinking about interventions that could improve the procurement process in order to facilitate higher uptake of sustainable energy technologies. Respondents were asked to indicate what kind of procurement assistance tools and services would be most useful to their organization for increasing the adoption of sustainable energy technology. While respondents indicated a high interest in the full range of tools and services options, providing technical specifications for sustainable energy technologies and the facilitation of group purchasing were ranked as most useful by a slight margin (Figure 7).

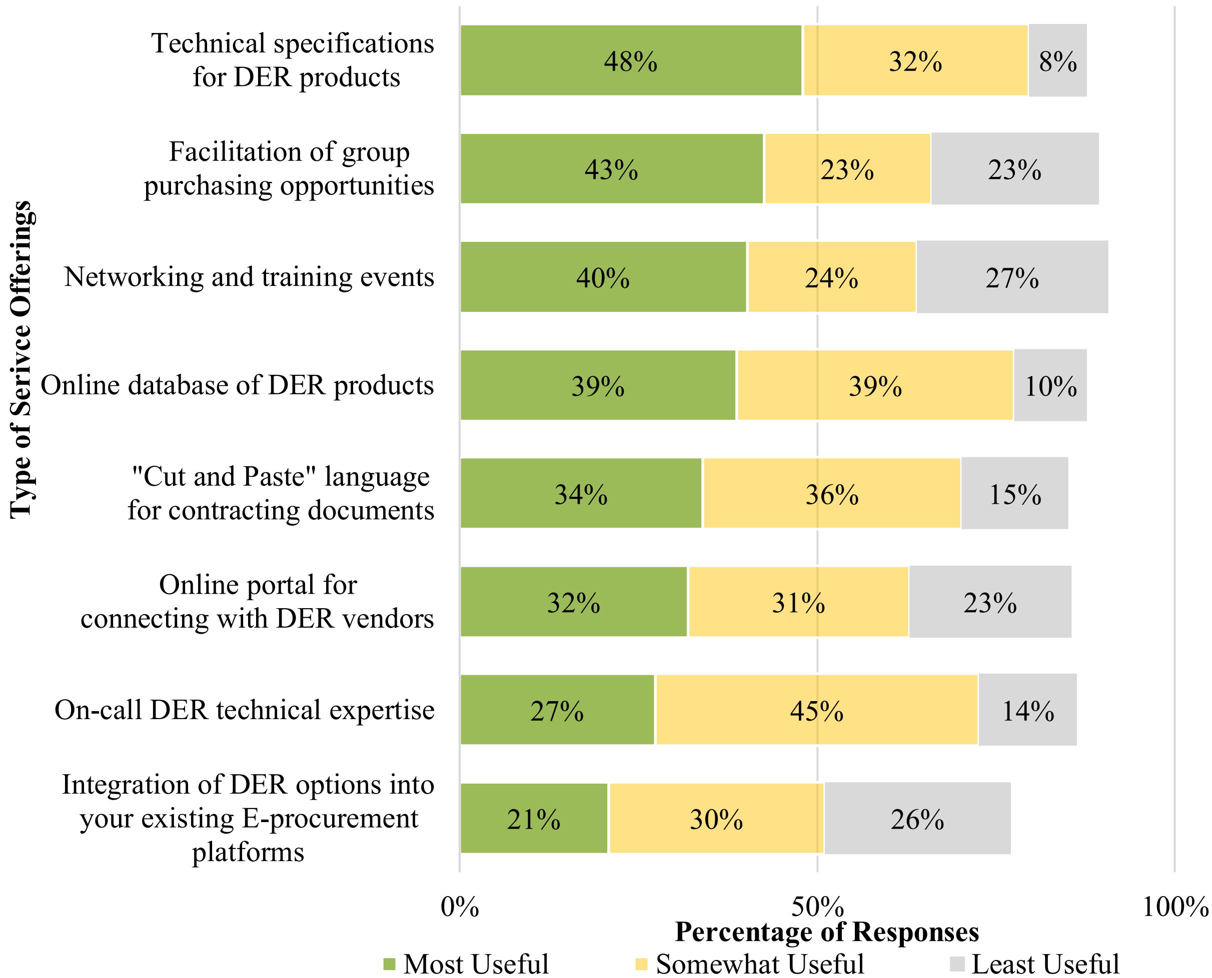

Figure 7. Respondent preference for types of procurement assistance tools and services for acquiring sustainable energy technologies

This high level of interest in the technical specification for sustainable energy technologies could relate to the finding that 89% of the respondents experienced bottlenecks when developing contract documents and specifying and selecting products. Having standard technical specifications that fit the specific needs of an organization can reduce the time it takes to purchase sustainable energy technologies.

The fact that ‘Facilitation of group purchasing opportunities’ ranked among the top three most useful tools and services could relate to the finding that 66% of respondents expressed that high cost and long-return on investment “Always” or “Often” prevent the procurement of new sustainable energy technologies. Services that help offset these costs, such as negotiating a lower cost through group purchasing opportunities, may be highly useful to buyers. Additional data on desirable services was obtained from a previous question, where respondents were asked to leave any additional comments for the research team. Fifteen (15) respondents explicitly mentioned that ‘help with cost’ would be useful to their organization. As one respondent wrote:

> *“The more [policymakers] can demonstrate a good life-cycle cost for the more sustainable options, the more successful initiatives for clean purchasing can be. For many sustainable energy technologies, business case development happens by a small team of energy SMEs and any support they can get is helpful. Traditional procurement professionals in corporate real estate often have no idea how to evaluate sustainable energy technologies and so the success depends on the small team of SMEs or energy managers to make a successful business case to the procurement managers. The impulse for traditional procurement organizations seems to always be first cost, and so, strong corporate goals in sustainability can help cut across these divisions, to shift to life-cycle cost perspective.”*

Overall, our survey findings identified several institutional barriers that may impede organizations from purchasing new sustainable energy products -- particularly barriers posed by limitations with existing procurement tools and lack of buy-in from key stakeholders when it comes to purchasing clean energy or energy-efficient products. However, the data also revealed some insights into how to address these barriers. Building on these insights, the following section presents some key recommendations for policies that can help increase the purchasing of sustainable energy technologies among large organizational buyers.

3.6 Limitations

Several limitations qualify the results of this research. First, the low response rate of this survey affected the statistical strength of some of the analysis. Although it was possible to obtain valuable overall insights, the low response rate limited our ability to examine the difference in procurement behavior across sectors, product category types, and type of procurement role. The low response rate also limited the usage of statistical tests. Additionally, the distribution of responses was slightly skewed, with greater representation from participants employed at organizations in the public sector. We received 62 responses from the public sector and 46 responses from the private sector. Further research might benefit from a more even distribution of responses between public and private organizations, as this could allow for more accurate comparison between the sectors.

4 Conclusion and Policy Implications

California has set ambitious carbon emission reduction targets for the next decade. While there are clear market barriers to sustainable energy technology adoption, it is important not to underestimate the significance of institutional barriers as well. Organizational factors play a significant role in determining how organizations make purchasing decisions. Meeting these goals requires interventions into the decision-making process that drive sustainable energy technology adoption. There are significant energy and carbon emissions reductions to be achieved by encouraging large organizations to buy more sustainable energy technologies. Procurement can be leveraged to achieve substantial emissions reductions by 'pulling' new sustainable energy technology into the market and phasing out carbon-intensive defaults. To successfully leverage procurement as a tool for increasing the uptake of sustainable energy products, policymakers must understand the institutional barriers which impact procurement within large organizations and aim policy interventions at sufficiently addressing them. The research presented in this paper provides policymakers with an overview of the procurement process and the various organizational factors that influence it, as well as recommendations on how to design policy interventions that are best-suited to addressing these barriers. By incorporating a better understanding of organizational factors impacting procurement, the purchasing power of large organizations can be an effective lever to achieve significant energy savings and help meet carbon reduction goals.

4.1 Policy recommendations based on survey results

Survey findings revealed several institutional barriers to sustainable energy technologies adoption within large organizations and helped to inform the design of a procurement assistance program within California. In this section, we offer recommendations based on our insights from this research and program development work for policymakers seeking to increase or encourage the adoption of sustainable energy technologies among large organizations. We also offer some immediate action items that business and community leaders can implement within their own organizations to increase capacity to adopt more sustainable energy technologies.

4.1.1 **Resolve conflict between prioritizing lowest first cost and lowest life cycle cost**

Our survey results revealed that organizations often face conflicting directives for which product attributes to prioritize during purchasing, which can have significant implications for the adoption of sustainable energy technologies. Out of all the product attributes (e.g., Made in America, recycled-content, etc.), a majority of respondents ranked lowest first cost as the highest priority for purchasing, followed closely by lowest life cycle cost. This prioritization pattern can prevent the adoption of sustainable energy technologies as these products tend to have the lowest life cycle cost but not always the lowest first cost. While not mutually exclusive, these attributes sometimes conflict with each other (e.g., what has the lowest upfront costs may not result in the greatest savings over the course of the product's life cycle; and what may have the best life cycle performance may not be the least expensive option upfront).

If organizations are prioritizing products with the lowest first cost the most, as demonstrated in our results, then they may be less likely to select sustainable energy technologies if there are cheaper options available. To reconcile this conflict, policymakers should provide clearer guidance and implement user-friendly tools in public procurement on what product attribute(s) to prioritize. For example, the default products when organizations are purchasing certain sustainable energy technologies (e.g., lighting, HVAC, refrigeration, etc.) should have the lowest life cycle cost as indicated by certain product labeling or standardized calculation method tools, the organizations could look for the cheapest option within those boundaries. There are already robust labeling programs (e.g., EnergyStar program) and standardized methods (e.g., National Institute of Standards and Technology's Life Cycle Costing Manual - NIST Handbook 135) that organizations can leverage. To reaffirm this new practice, policymakers could also encourage standardized life cycle saving tracking of cost savings in addition to the typical model of annual cost savings tracking, which tends to reaffirm the prioritization of lowest first cost. By tracking the cost saved in the product life cycle, organizations will be encouraged to place greater emphasis on assessing the performance of products over several years or a lifetime of use, rather than product’s initial cost, leading them to prioritize products that are more sustainable and use less energy.

4.1.2 **Message to diverse actors on the benefits of sustainable energy technology**

Our survey findings demonstrate that there are multiple sets of actors involved in the decision-making process of technology acquisition within a given organization. Those sets of actors have different and sometimes conflicting motivations, which makes securing funding or approval a common bottleneck as demonstrated in our survey results. To overcome this barrier, policies that aim to encourage the adoption of sustainable energy technologies must be effectively communicated to the major influencers at each level of the decision-making process. This multi-level approach may requires tailoring the message to address factors that matter most to each type of role. For example, the motivations of a financial officer differ from those of a facility manager. To effectively communicate why purchasing sustainable energy technologies should be made a greater priority in the procurement process, the rationale presented to a financial officer may highlight the potential energy cost savings over the lifetime of the product. On the other hand, the rationale for prioritizing sustainable energy technologies presented to a facility manager may focus more on how the product could improve the ease of operations or its ability to be integrated with existing equipment on a given site. One strategy for building these tailored communication channels would be to facilitate internal networking events where major influencers can express their various goals and provide training on how to develop effective justifications for the various levels of approval.

4.1.3 **Improve existing procurement tools and provide new options**

Survey results also revealed a clear need to address the limitations of existing tools which limit organizations' capability to purchase new sustainable energy technologies. Despite having several procurement tools in place, including standardized contract language and technical specification templates, respondents indicated that their current resources did not facilitate purchase of sustainable energy technologies. Policies aimed at improving or regularly updating standardized contract language may help make it easier for organizations to contract for sustainable energy technologies, while also expedite the contracting process in general. For example, standardized contract templates could be updated to include language that requires organizations to prioritize energy efficiency attributes when purchasing certain energy-consuming products. New standardized contract language could also be developed for energy service contracts in order to ensure that energy savings are realized during new construction or renovation projects. Additionally, despite reporting that they frequently used standardized technical specifications for products, most respondents still reported difficulty specifying and selecting new sustainable energy technologies. This disparity suggests that, while organizations have technical specifications currently in place, these specifications may not apply to sustainable energy technologies. Therefore, state or local agencies can develop up-to-date technical specifications for sustainable energy technology products based on regional requirements (e.g., weather patterns, state decarbonization goals) which may reduce resources during the procurement process. Policymakers could also support the creation of a state-wide or local database of designated sustainable energy technologies which buyers could use to more easily identify, select, and purchase energy-saving products in a variety of categories. Having clearer acquisition language aimed at sustainable energy technologies and standardized contract and technical specifications will enable organizations to obtain sustainable energy technologies easier by reducing their administrative burden.

Intervention aimed at changing the procurement process within large organizations is a clear opportunity to increase the adoption of sustainable energy technologies, but it is a highly complex process. While complexity represents a challenge for policymakers, understanding this complexity also opens up more opportunities for a variety of policy vehicles to intervene. To resolve the institutional barriers that organizations face in the acquisition of sustainable energy technologies, policymakers must understand the internal decision-making and processes around technology adoption (i.e., procurement) within large organizations in order to more effectively encourage the uptake of sustainable energy technologies across multiple sectors. By understanding these institutional barriers (in addition to the market barriers commonly focused on by academics and policymakers alike) one can design and implement policies that successfully leverage procurement to increase the adoption of sustainable energy technologies amongst large organizations throughout the country. Policymakers would do well to invest in additional research on institutional barriers to sustainable energy technology adoption amongst large organizations.

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